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REPORT
OF THE
DEFENSE SCIENCE BOARD
TASK FORCE
ON

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DEFENSE NUCLEAR AGENCY

APRIL 1993

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OFFICE OF THE SECRETARY OF DEFENSE
WASHINGTON, D.C. 20301-3140

DEFENSE SCIENCE
BOARD

May 3, 1993

MEMORANDUM FOR UNDERSECRETARY OF DEFENSE (ACQUISITION)

SUBJECT: Report of the Defense Science Board (DSB) Task Force on Defense Nuclear Agency

I am pleased to forward the final report of the DSB study on the Defense Nuclear Agency (DNA), which was chaired by Dr. John M. Cornwall. The report responds to the recent Authorization Conference Report of the House and Senate Armed Services Committees and parallels an OSD/JCS review group study of DNA's organization and management. It covers primarily scientific and technical matters relative to the Agency and did not address the review group issues, except to the extent that scientific and technical findings make them pertinent.

In developing their conclusions and recommendations, the Task Force chose to conduct its review in a broad context of the future of United States nuclear and conventional weapon technology strategy. The issues then became:

- not just DNA, but how the DoD in total will meet its continuing nuclear responsibilities in this uncertain world, and;
- not just nuclear, but how the DoD will make the best use of advanced technology, originally developed for nuclear purposes, to meet future non-nuclear needs particularly in countering all weapons of mass destruction (WMD). For the purposes of this report, WMD are considered to be the weapons systems and their infrastructure.

Regarding these priority issues, the Task Force recommends that 1) DNA continue to be the focal point for needed DoD nuclear expertise, and 2) that its charter be modified to provide focus for non-nuclear activities of critical importance to the DoD; specifically, give DNA clear authority to:

- conduct technology base development for advanced conventional munitions, and
- become a focal point for technologies related to non- and counter-proliferation of WMD

In addition, the Task Force made recommendations regarding underground nuclear effects testing, warhead stockpile management, military radiobiology research, and the management structure which ensures the best use of DNA developed science and technology.

I fully concur with the recommendations of the Task Force, recommend that you review the Executive Summary, and forward the report to the Secretary of Defense.

John S. Foster Jr.

John S. Foster, Jr.
Chairman

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DEFENSE SCIENCE
BOARD

May 3, 1993

MEMORANDUM FOR CHAIRMAN, DEFENSE SCIENCE BOARD

SUBJECT: Report of the Defense Science Board (DSB) Task Force on Defense Nuclear Agency

Attached is the final report of the DSB study on the Defense Nuclear Agency (DNA). The study was in response to the Authorization Conference Report of the House and Senate Armed Services Committees and is part of a larger effort involving senior representatives of the Office of the Secretary of Defense (OSD) and the Joint Staff. The Terms of Reference for the DSB Task Force called for it to provide input on scientific and technical issues relevant to DNA while the OSD/JS Review Group was requested to consider the organization, management, and funding of DNA. This report considered these latter issues only to the extent that our scientific and technical findings made it pertinent.

The Task Force reviewed all of the major scientific and technical projects being conducted or planned by DNA and had discussions with both the government and industry customers or counterparts regarding the value of and the technical competence of DNA in accomplishing the projects. In all cases, the comments were positive.

In addition, and because of the noticeable and distressing tendency of the Services to reduce their nuclear related expertise, the Task Force chose to conduct its review in the broader context of the future of United States nuclear and conventional weapon technology strategy. The issues then became:

- not just DNA, but how the DoD in total will meet its continuing nuclear responsibilities in this uncertain world, and;
- not just nuclear, but how the DoD will make the best use of advanced technology, originally developed for nuclear purposes, to meet future non-nuclear needs, particularly in countering all weapon systems of mass destruction and their infrastructure (WMD).

Our report addresses these issues in detail; our primary recommendations are 1) that DNA continue to be the focal point for needed DoD nuclear expertise, and 2) that its charter be modified to provide focus for non-nuclear activities of critical importance to the DoD; specifically, give DNA clear authority to:

- conduct technology base development for advanced conventional munitions and
- become a focal point for technologies related to non- and counter-proliferation of WMD.

Additional recommendations involve underground nuclear effects test cessation, warhead stockpile management, military radiobiology research, and the management structure which ensures the best use of DNA developed science and technology. These are covered in the executive summary.

We believe that our conclusions and recommendations will provide a sound basis for maintaining the essential nuclear and non-nuclear technological competencies for the United States.

John M. Cornwall
Chairman

Attachment

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EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

This Task Force was convened in response to the Authorization Conference Report of the House and Senate Armed Services Committees and is part of a larger effort involving senior representatives of the Office of the Secretary of Defense (OSD) and the Joint Staff. The Terms of Reference (TOR) for the DSB Task Force (see Appendix 1) call for it to provide input on scientific and technical issues to this senior review group, chaired by Dr. George Schneiter; in turn, the TOR of the senior review group call for it to consider the roles and missions, management, program content, and funding of the Defense Nuclear Agency (DNA). The DSB Task Force did not concern itself with these latter issues except to the extent that our scientific and technological findings made it necessary.

The Task Force membership, and a list of government advisors are in Appendix 2.

1. REPORT HIGHLIGHTS

The Task Force recommends that:

- 1) DNA continue to be the DoD focal point for nuclear expertise
- 2) The DNA charter be modified to provide focus for non-nuclear activities of critical importance to the DoD, specifically, giving DNA clear authority to:
 - conduct technology base development for advanced conventional munitions, and
 - become a focal point for technologies related to non- and counter-proliferation of weapon systems of mass destruction and their infrastructure (WMD)
- 3) Anticipating cessation of UGETs, DNA should aggressively pursue technology development for AGT, AGT/UGT correlation and advanced computations, with emphasis on new theater scenarios, but with the ability to reconstitute for UGT resumption or AGT for large strategic threats within a year or two.

2. GENERAL REMARKS

Our study should not be thought of narrowly as a review of DNA's scientific and technical competence (although it is that, in part), but should be placed in the broad arena of future United States nuclear and conventional-weapon technology strategy. The study is, as called for in the TOR, restricted to science and technology issues, but many of these issues are directly affected by their management and organization, both inside and outside DNA. Therefore, we will comment, for use by the Schneiter panel,

on how we believe nuclear and related science and technology is best governed.

We agree with the HASC-SASC Report that "DoD must retain a focal point within the Department for nuclear weapons expertise", which is essential both to meet traditional, though evolving, nuclear requirements and to carry out missions in arms control, monitoring, and dismantlement. Several further assumptions guided the study:

- 1) Although the U.S. budget for nuclear and related functions will diminish in the future, nuclear weapons, both U.S. and foreign, are here to stay and cannot be ignored.
- 2) The FSU and PRC strategic threats will endure, but the most likely nuclear scenario in the foreseeable future (barring catastrophic upheavals in the components of the FSU) will involve relatively minor powers and relatively few weapons.
- 3) Nuclear deterrence cannot be the only U.S. option for response to such scenarios. The U.S. must be prepared to respond broadly, with options ranging from dissuasion to destruction, to nuclear and other WMD, and direct-action responses may be constrained to be conventional in some likely scenarios.
- 4) Underground testing (UGT) may or may not continue past 1996, but it is wisely conservative to plan for its absence.

In the next sections, we give our specific conclusions and recommendations. The Briefing Report goes into more detail on DNA's nuclear core competencies, new missions which could be supported by these and related technologies, and possible expansion of the DNA conventional technology base.

In reading this report, one should keep in mind the following thoughts:

The issue is not just DNA; it is how the DoD including OSD, Services, CINCs, and DNA - will meet its continuing nuclear responsibilities in the future.

The issue is not just nuclear; it is how the DoD will make the best use of advanced technology originally developed for nuclear purposes to meet critical future non-nuclear needs.

3. SUMMARY OF SPECIFIC CONCLUSIONS AND RECOMMENDATIONS

We state these in the form of answers to key questions, most of which address issues specifically raised in the TOR. Details of our findings are found in the Briefing Report.

1) Is DNA the appropriate DoD focal point for maintaining nuclear competence?

Possible alternatives to DNA include maintaining focal points, where appropriate, in the Services; giving other DoD laboratories the responsibility for nuclear and related technologies; or creating some mechanism for the DOE laboratories to deal in a substantial way with some of DoD's nuclear concerns.

We find that DNA is the only continuing DoD repository of nuclear expertise in the combined areas of science and technology, technology development, operations, and oversight functions. Over the years, DNA has done a first-rate job of maintaining this expertise, although at times it has clung too doggedly to problems whose ultimate solution remained, for purely technical reasons, out of reach.

Behind this finding is the observation that the Services are not fully maintaining nuclear-related skills to meet future DoD-wide needs. In some cases, the Services are withdrawing from supporting nuclear competence beyond immediate operational needs, and in another case maintaining system-specific skills which are not readily transferrable.

Other DoD agencies (e.g., ARPA) and labs are not pursuing programs to maintain nuclear competence on weapon-related matters. The DOE labs are, of course, very strong in nuclear science and technology, but have no operational or warfighting capabilities; no established way of providing support to CINCs; and in any event, DNA's technology programs are broader than DOE's in such areas as weapons effects, survivability, electromagnetic propagation, and so forth.

Moreover, DNA is competitive with, or in certain instances, better than, the DOE labs in technology areas of overlapping interest. (Competition between DNA and a DOE lab is a little hard to judge, since DNA maintains its technology base through industry, and the lab does in-house research). DNA's approach assures technology transfer as evidenced by the success of the major primes and their subcontractors (who are part of the DNA core capability).

We recommend that DNA continue to be the primary focal point for DoD nuclear expertise.

2) In an era of diminishing budgets for nuclear matters, how is DNA to maintain its essential nuclear capability, including an adequate body of technically-qualified people?

We find that there are numerous close relations between DNA's historical nuclear competence and many needs that the U.S. now faces in countering WMD, and that it is logical on purely technical grounds that DNA be made a focal point for such activities. Moreover, these additional missions, because of their newness and importance, are likely to be attractive to the skilled

technologists needed to ensure continuing nuclear competence. There are synergisms between DNA's historical nuclear missions and new missions such as counter-proliferation and advanced non-nuclear munitions.

For example, pulsed-power research for X-ray simulators has been indispensable in highly successful research on the electro-thermal cartridge, which is to propel a projectile from a standard 5" Navy gun to much greater ranges than can an ordinary cartridge.

Other DNA technologies, with important non-nuclear applications, include advanced computational programs for blast, shock, lethality, and hazard dispersal; as well as non-nuclear above-ground testing (AGT) in these areas; conventional underground penetrators and their effects; and other uses of pulsed power in conventional weapons applications.

There is a risk in recommending that DNA adopt a substantial non-nuclear role, which is that DNA itself, like certain Service labs, might downplay its historical and still-essential nuclear role and become a largely non-nuclear agency. On the other hand, if DNA is viewed strictly as a nuclear agency, it is nearly certain that its competencies will decline along with its budget. As the nuclear budget declines, and along with it high-level DoD concern with nuclear matters, there is a real risk that diffusion and dismemberment of nuclear technology will leave the U.S. with not enough people - or perhaps more exactly not enough good people - to carry out essential core nuclear missions at the necessary high level.

A critical mass of good people and a technology base can, however, be maintained by tasking them with new and important problems directly related to nuclear technologies. We accept the risk of ultimate subordination of nuclear technology to non-nuclear technology at DNA as one which can be averted, given sufficient high-level DoD attention, while if nothing is done as nuclear budgets slide, it is a virtual certainty that still-essential nuclear skills will be lost.

We therefore conclude that in order to protect nuclear competence in an era of diminishing nuclear budgets, it is necessary to sustain and build related non-nuclear competence in DNA.

These related non-nuclear skills which DNA is in a position to develop are in many cases directly related to protecting U.S. responses to theater nuclear threats, or more generally to countering the spectrum of WMD. Secretary Aspin has already listed countering WMD as one of his top priorities, and the Defense Science Board, in its study last year on this subject, concluded that the present course of U.S. technology development for countering WMD would lead over the next 10 years or so to only a fair capability to respond to such threats. Given our conclusion above that it is necessary to build related non-nuclear competencies to sustain essential nuclear skills, we recommend that:

Serious consideration should be given to making DNA a focal point for technology issues concerned with countering WMD, including theater nuclear survivability, counter-proliferation, and advanced conventional munitions.

Of course, such a recommendation goes far beyond DNA itself, and so we are asking for attention to those issues at the highest levels in DoD:

We urge the Department and the Secretary to define as priority missions in addition to DNA's nuclear missions:

- 1) Mitigating the effects of hostile use of primitive nuclear weapons on theater forces;
- 2) Adapting nuclear-related technologies to develop advanced conventional munitions to counter WMD.

Next we make some recommendations dealing with specific points raised in the TOR such as underground effects testing (UGET), the only component of UGT that we consider. Also dealt with are stockpile management; the Armed Forces Radiobiology Research Institute (AFRRI); and science and technology management issues.

3) What happens if underground nuclear effects tests (UGET) stop?

We begin by pointing out that there is an essential difference between weapons effect tests, the only test component we consider, and tests for weapon development, safety, and stockpile reliability, and that nothing we say about effects tests should be construed as relevant to these other areas of testing.

UGETs address the effects of U.S. nuclear weapons on an enemy's forces, and also the survivability of U.S. forces to enemy weapons. As for effects of U.S. weapons, even after decades of UGETs, there are still uncertainties (e.g., enemy silo hardness and response; effects of high-altitude nuclear weapons) which are difficult or impossible to address with UGETs. This has made it necessary for DNA to develop, over these decades, a vigorous and sophisticated above-ground testing (AGT) program with non-nuclear simulations as well as extensive first-principle computations, and this will have to continue, UGET or not.

Survivability is today a more important issue, as threat scenarios evolve from multi-megaton strategic exchanges to theater use of a few relatively low-yield nuclear weapons. Many current and planned U.S. theater systems may be vulnerable to these small-yield weapons, because they use advanced and increasingly-vulnerable technology (e.g., smaller-size detectors or focal plane arrays; more closely-packed chips and memories.)

We single out one issue of particular concern, which, as it happens, cannot be addressed with UGETs. There is interest in developing precision-

strike munitions (CEP 1-3 meters), which use accurate fixed-target location and on-board guidance, both supported by GPS. This 1-3 meter accuracy could possibly be degraded by the disturbed ionosphere produced by even a modest high-altitude nuclear weapon, even though the GPS satellites and ground-based sources are completely unaffected by the weapon. An issue like this can only be addressed with non-nuclear simulations and computations.

On the other hand, there are effects which are difficult to simulate with AGT, but which can be (and are) addressed with UGET. These include: simultaneous exposure to X-rays, neutrons, and gamma rays; large-area or system-level exposure to X-rays, especially at high fluences; and achieving fluences thought to be required to test missile and re-entry vehicle hardness in multi-megaton strategic scenarios. It is certainly possible that a new system as yet untested in a UGET could have unanticipated vulnerabilities to these phenomena, especially since systems of the future will be smaller and more complex. Many of these vulnerabilities can be prevented with more conservative system design, with of course performance penalties if the system is made larger or heavier by shielding or because of design margins.

We conclude that UGETs provide the most authentic effects environment, except for exoatmospheric tests, at high fluences and relatively large test objects, but AGT radiation simulators provide adequate test capabilities over a limited range of radiation environments and object size. Therefore, cessation of UGETs will limit our ability to assure the radiation hardness of larger equipment and systems for certain threat levels. Some important effects (e.g., vulnerability of GPS accuracy to high-altitude bursts) cannot be addressed by UGETs. Provided that some design limitations are accepted, AGT, simulation, and computations can address most theater scenarios effectively.

Note what this conclusion does not say: it does not promise that AGT and computations can replace UGETs, especially for the greater radiation levels postulated for strategic scenarios, nor does it say that present-day AGTs, simulations, and computational facilities are fully adequate. Better development, within limits, in these areas will be an important component of DNA's research in the future, but we see no pressing need to develop simulators capable of fluences in the range of 40 cal/cm² over large objects. It will also be important to maintain the DNA technology base for UGTs at a level permitting reasonably-rapid reconstitution. We recommend:

DNA should aggressively pursue the technology development for AGT, AGT/UGT correlation and advanced computations, with emphasis on new theater scenarios, but with the ability to reconstitute for UGT resumption or AGT for large strategic threats within a year or two.

4. Is Stockpile Management to be a DNA or a Service responsibility?

While we were asked to look primarily at the Science and Technology mission, we were well briefed on DNA's operational mission to support the

employment of nuclear weapons by the military forces. Stockpile management constitutes a major portion of this mission, and we believe it is a genuine nuclear weapon core competency. This function includes maintaining near real-time accountability for every weapon in DoD custody, controlling maintenance and logistics activities, conducting top-level inspections of all nuclear-capable units, and planning and exercising for weapon-related emergencies. This operational mission accounts for a small fraction of DNA's budget, but it occupies a significant fraction of its people.

The nation must sustain responsible stewardship of the enduring stockpile and be able to reconstitute and redeploy nuclear forces should that be necessary. Centralized control of the stockpile management function is essential to properly manage competing priorities and ensure the highest safety and security standards are uniformly set and achieved. We also believe there is substantial synergy between this operational mission of DNA and its Science and Technology work. Moreover, as CINC and Service nuclear budgets and interest levels diminish, DNA can efficiently absorb any stockpile management responsibilities the CINCs/Services might shed.

As a result, we conclude that DNA should retain its stockpile management mission. In that context, we also recommend that weapons in the inactive reserve stockpile be formally allocated to DNA, thereby assigning them responsibility for warhead reconstitution and recertification.

5. What is the future of military radiobiology research in DNA?

For years the Armed Forces Radiobiology Research Institute (AFRR) has been an integral part of DNA, carrying out research on the health effects of high levels of radiation, with particular emphasis on prompt effects which degrade military capability. Current plans call for the transfer of AFRR to the Uniformed Services University of the Health Sciences (USUHS) in October 1993. DNA is quite concerned over this pending transfer, both on the grounds that the primary mission of AFRR will erode away at USUHS, and on the (implicit) grounds that the transfer is really partial dismemberment of DNA. In fact, the issues surrounding AFRR are complex, and the Task Force members supported positions both pro and con regarding the transfer out of DNA. AFRR is a unique institute in the U.S., with little or no radiation biology being done under DOE auspices or in Service labs. Its primary mission is important if unglamorous. AFRR's interests are evolving in other directions, especially concerning treatment and mitigation of radiation effects in humans exposed to radiation levels ranging from low to high (e.g., astronauts, troops struck by fragments of depleted - uranium penetrating rounds.) These new areas of interest are also important, and in a much wider context than survivability of troops.

In our opinion, the pivotal issue is whether radiobiology competence will be maintained better in the essentially academic USUHS environment of broad research in the biological and health sciences, or whether that broad environment in USUHS will, over time, submerge the radiobiology work of interest to DNA. The point is that intellectual market forces may lead to a

decline in funding and in quality personnel if military radiobiology is seen as a dirty business. If this happens, it would be a loss to both DNA and to the nation, but we find no compelling reason to believe that it must happen if AFRRRI is transferred to USUHS.

We conclude that AFRRRI's missions of troop survivability, as well as mitigation and long-term treatment of human radiation effects, are important and must not be allowed to disappear, whether or not AFRRRI leaves DNA.

The question then arises as to how to ensure the continuing strength of AFRRRI if it is transferred. As is usual in these matters, the single most important factor is adequate funding which would, of course, be in DNA's hands if AFRRRI were to remain there. There is nothing to prevent DNA from spending funds on AFRRRI at USUHS, just as it would on any other contractor, provided of course that the funds are appropriated for DNA. There are many instances of university components receiving major funding from outside sources (e.g., the Lawrence Berkeley Laboratory). The funder cannot micromanage what happens in an academic setting, but there is still effective control through the funding mechanism and through periodic oversight and review. On the other hand, if AFRRRI funds are not appropriated and the DoD fails to support radiobiology missions, AFRRRI will suffer whether at DNA or USUHS. Protection of the military radiobiology mission and its funding will require attention at high levels of the DoD, in line with our recommendation under point 2 above. We therefore recommend that plans for the completion of the transfer of AFRRRI to USUHS should be reviewed by the Deputy Secretary of Defense: these plans should include a commitment by USUHS to maintain at a high level of quality the military radiobiology efforts of AFRRRI, and a management plan to ensure this focus and quality. DNA should continue a close relation with AFRRRI as funds provider and in directing the use of these funds. The DNA budget should be adjusted to accommodate this need. A review board should be convened from time to time to assess the success of the transfer of AFRRRI to USUHS.

6. What management structure ensures the best use of DNA-developed science and technology?

Well before the apparent diminishing of nuclear tensions associated with the breakup of the FSU, DNA was slowly losing visibility in the DoD. In part this had to do with the maturation of certain areas of weapons effects studies, either because they were considered well-enough understood or because it was felt that further effort could be only marginally productive, given the ban on all but limited-yield underground tests. Whatever the reasons, the Director of DNA used to be a three-star military officer, but this job now goes to a two-star; and DNA used to report to the JCS as well as to the DDR&E. Currently, it has no direct connection to the Joint Staff, and reports only to the DDR&E.

We believe this loss of visibility and erosion of connections at higher levels in the DoD are unwarranted these days, for several reasons. First, in several areas, notably advanced computations, pulsed power and its offshoots, and radiation-hardened electronics, DNA is nurturing a collection of high-quality technology bases important not only for nuclear missions but for advanced conventional applications as well. Second, both nuclear and non-nuclear technologies of the type DNA is supporting continue to be quite important for the post-cold-war era. Third, although the Services as a whole are diminishing their efforts in nuclear-related technology, the same Services and CINCs find DNA to be indispensable in supporting their operational needs in ways ranging from various technology applications to target analysis to stockpile management.

We conclude that the current high-level performance of DNA and the contractors constituting the strengths of its technology bases, as well as the importance of the post-cold-war missions supported by these technologies, warrant a reconsideration of DNA's management and connection within DoD. A continued loss of visibility, along with a diminishing nuclear budget, could weaken these technologies considerably.

The options for strengthening DNA's management seem to come down to keeping the director as a military officer, but of three-star rank, or changing the directorship to a civilian with great and widely-recognized strengths in appropriate technological disciplines; the deputy would then be a two-star. The first option emphasizes DNA's role in support of operational commanders; the second emphasizes the building of DNA's technological strengths, especially - if our other recommendations are to be followed - building these strengths in advanced conventional technology. In any event, strengthening the management of DNA can only succeed if its connections with appropriate elements of DoD are also strengthened.

We recommend that the DNA Director should either be a three-star with a long-term contract, with a civilian deputy very strong in science and technology, or a civilian of such strengths with a military deputy of two-star rank. The Director should be prepared to carry out a long-term strategy to build advanced conventional technologies, while maintaining a high level of nuclear expertise. DNA should report to USD(A), and have strong connections both to the Joint Staff and to the ASD for Counter-Proliferation and Nuclear Security.

Our Briefing Report follows.

BRIEFING REPORT

DEFENSE SCIENCE BOARD TASK FORCE

ON

DEFENSE NUCLEAR AGENCY

APRIL 1993

Dr. John M. Cornwall
Chairman

The purpose of this Briefing Report is to provide an overview of the findings, conclusions, and recommendations of the Defense Science Board Task Force on the Defense Nuclear Agency. The Task Force met from January through March, 1993.

DSB TASK FORCE MEMBERSHIP

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**Dr. John Cornwall, Chairman
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VAdm (Ret) John T. Parker
Gen. (Ret) Donn Starry
Dr. Richard L. Wagner, Jr.**

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Executive Secretary

Dr. Eugene Sevin

DSB Secretariat

**Col Ray Whitehouse
Maj Keith Larson**

Support

**Lt. Col Stephen Blanchette
Mr. Ed Burke**

Task Force members were enlisted from a wide range of distinguished executives from industry, academia, and government who have had extensive experience in nuclear issues over the past several decades.

TERMS OF REFERENCE

- **Provide inputs on scientific and technical issues to an OSD-Joint Staff Review Group, headed by Dr. George Schneiter, Director, Strategic and Space Systems.**
- **Specifically:**
 - 1) Review DNA Technology Programs**
 - 2) Determine the impact on national security of no nuclear effects tests**
 - 3) Consider how DoD best maintains its essential nuclear capability**
 - 4) Consider expanding DNA's role in Non-nuclear areas where it has special expertise**
 - 5) Consider closer collaboration with other DoD and USG laboratories**

The Task Force terms of reference are summarized here. We were chartered to provide inputs on the scientific and technology issues shown above to the OSD-Joint Staff Review Group on DNA.

The issues defined or set the stage for how the Task Force organized itself and selected areas for review.

TASK FORCE GUIDELINES

- Not just a review of DNA; address in context of broader issues of the future of U.S. Nuclear Weapons and Related Technologies
- Restricted to Science and Technology, but free to report on management and organizational issues that directly affect best use of science and technology
- Enabling language in HASC-SASC Conference Report:
 - 1) DoD must retain a focal point for nuclear weapons expertise
 - 2) Must meet traditional requirements (e.g., operational support, hardening, effects tests)
 - 3) Must support new roles (e.g., dismantlement, non-proliferation, treaty verification technology)
 - 4) Review to be conducted "at highest level of DoD"

In an initial meeting with Dr. Schneiter, the Task Force adopted the guidelines shown here as overriding guidance for their deliberations.

Particular emphasis was placed on the Senate-House Conference Report Language which accompanied the Appropriations Bill.

ASSUMPTIONS

- 1) Nuclear Weapons are here to stay and cannot be ignored (either ours or theirs)**
- 2) Testing (past 1996) may or may not continue, but it is wisely conservative to plan on its absence**
- 3) The FSU and PRC strategic threats continue, but there are many other possibilities. The most likely nuclear use scenario in the foreseeable future (barring upheavals in the FSU) will involve relatively minor powers and only a few weapons**
- 4) In the U.S., budgets for all things nuclear will diminish**

In line with those guidelines, the Task Force used the assumptions shown here as a further basis for their findings and conclusions.

BRIEFINGS RECEIVED

HQ DNA

- Director
- Deputy Director
- Operations
- Field Command
- Nuclear Effects
- Simulation
- Lethality
- C³I and Weapon System Operability
- AFRRI
- SAGE

SERVICES

- USA
- USN
- USAF

CINCS

- STRATCOM
- EUCOM
- SHAPE

OTHER DoD

- NRL
- USANCA
- SDIO
- Army SDC
- AF Phillips Lab
- Navy SSPO

OTHER GOVERNMENT

- CIA
- DOE Labs
 - Livermore
 - Los Alamos
 - Sandia

INDUSTRY

- Jaycor
- Maxwell
- SAIC
- IFPA
- Physics International

In considering how best to maintain the nuclear competencies which the DoD is expected to retain indefinitely, the Task Force met with the government and industrial organizations shown on this chart. This extended survey of the "DNA community", together with our examination of DNA's RDT&E programs, provided the basis upon which we have reached our conclusions and recommendations.

DNA CORE NUCLEAR COMPETENCIES

- 1) Nuclear Weapons Effects Phenomenology**
 - Advanced numerical simulations
 - Blast, shock, X-ray, and thermal effects in all media
 - Electronic effects (Radar, Communications, IR, EMP)
 - Human response
- 2) Nuclear Weapons Effects Simulation**
 - Design and operation of Underground Effects Test (UGET)
 - Design and operation of Aboveground radiation simulators
 - Design and fielding of airblast/shock/thermal simulators
 - Specialized instrumentation and facilities
- 3) Vulnerability, Hardening, and Survivability (VH&S) Methodologies**
 - Radiation hardened materials and electronics
 - Testable hardware designs
 - Target Analysis and Damage Assessment
- 4) Advanced Nuclear Related Technology Applications**
 - Treaty verification/compliance technologies
 - Non-proliferation technologies
 - Denuclearization support
- 5) Nuclear Weapon Employment Support**
 - Stockpile Management
 - Weapon security, storage, inspection, training
 - Incident/accident emergency response
 - Nuclear weapon system safety
 - Employment strategy, doctrine, tactics, force structure
 - Methods for mission planning and targeting

Nuclear competencies of continuing importance to the DoD include establishing weapon requirements and characteristics, designing, developing, and testing of new weapons, maintaining the safety, security, and surety of the nuclear stockpile, and a host of other activities associated with employment and deployment of nuclear weapons. We consider the five elements of these competencies shown in the Chart to be core nuclear competencies which the DoD must retain indefinitely. The first three of these traditionally have been DNA's primary responsibility, with implementation of VH&S methodology for particular weapon systems being the responsibility of the developing Service. The fourth competency area is of more recent vintage, and one for which DNA is well suited, while the fifth area has long been a DNA responsibility.

The Task Force was dismayed to learn how rapidly the Services are reducing the nuclear competence essential to the Unified and Specified Commands. DNA, on the other hand, continues to provide essential support to the CINCs and other commanders to protect their warfighting assets

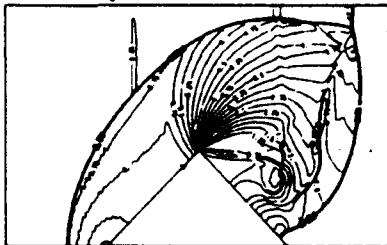
against nuclear effects. Nuclear Weapon Employment (Operations) Support, which includes stockpile management, training, inspection and security, has been a function of DNA since its inception. Our discussions with the CINCs and Services made clear the importance of this support and the fact that Service capability is eroding rapidly. If not available from DNA, it would have to be provided by an equivalent source. Challenges of reconstitution demand that this capability not be lost; thus, we view it as a core nuclear competency.

Technology examples of DNA's activities are reflected on the following charts.

ADVANCED COMPUTATIONAL METHODS

Validation of Shock Diffraction Over a Wedge

Computer Simulation



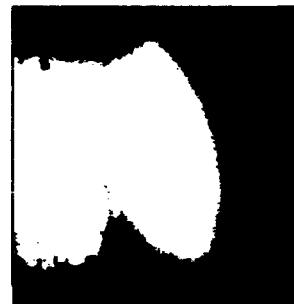
Experimental Interferogram



Turbulent Dust Injection in Double Mach Flow



**DIAMOND FORTUNE
Simulation:
Interaction of Airblast
with Non-Ideal Surface**



This chart shows examples of DNA's Advanced Computational capabilities to model complex explosion dynamics-generated flowfields.

The two lefthand figures show a computer simulation and photograph of an actual experiment representing complex mach shock formation during the explosively produced flow over a wedge. The contour lines represent constant density levels with contour lines of the computer simulation calibrated to the same values. This allows both figures to be overlaid for comparison.

This same computational simulation capability has been expanded to include 2-phase dusty flows, direct simulation of large scale turbulence, and shock diffraction effects due to surface preconditioning from source effects. This capability has been validated by comparison with above-ground nuclear tests such as TRINITY, PRISCILLA, and HOOD, and has been used to design special testbeds for underground cavity nuclear tests such as DIAMOND FORTUNE.

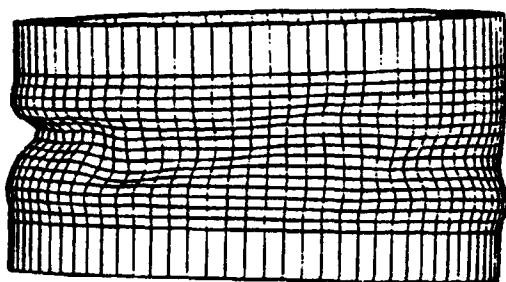
3D CALCULATION GRAPHIC



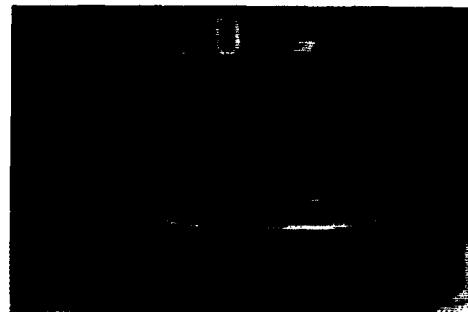
q1

DNA is validating their predictions of nuclear particulate clouds. A wind blown, three dimensional prediction of the water/ice cloud produced by the IVY KING nuclear event was performed using the DICE-MAZ and TASS hydrodynamic computer codes. A ray tracing program was used to estimate the cloud that one would actually see given the viewing angle and lighting conditions. A photograph of the nuclear event is shown here for comparison.

**COMPARISON OF PREDICTED AND OBSERVED
DEFORMATIONS, MISTY PORT II, HIGH EXPLOSIVE TEST**



TRANAL Calculation

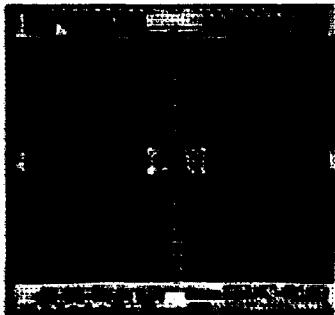


Observed Response

DNA has developed sophisticated computational methods for predicting the large deflection response of structures to airblast and ground shock. These methods require validation against precision test data. This small scale model of an SS-18 missile silo headworks deformed by a blast compares favorably with preshot predictions.

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RADIATION-HARDENED MICROELECTRONICS AND ELECTRO-OPTICS



Technical Requirement

- Develop affordable electronics with intrinsic radiation hardness

DNA Activities and Accomplishments

- Developed family of hardened (10^{11} rads (SI)/sec) memories with increasing capacity and processing speeds
 - Use standard microchip manufacturing lines
 - 16kb → 64kb → 256kb → 1+Mb (future)
- Used in Trident I/I, GPS, MILSTAR, GBI, and FEWS

Impact

- System operability in disturbed environments without interruption
- Supports very high speed processing

In the past, the development of radiation-hardened technology was directly supported by the various system program offices and system prime contractors and resulted in overlapping and duplicative efforts. The expertise and resources available to these technology programs was limited and thus often resulted in application-specific programs characterized by low-volume production, unknown reliability and, thus, high application cost.

Future satellite and strategic missile upgrades will utilize high density, submicron integrated circuits and electro-optics components. These strategic systems will need to be hardened to both nuclear and natural radiation effects.

DNA has taken the leadership role for the development of generic radiation-hardened electronics technology. The DNA program emphasizes the application of processes and manufacturing equipment used in commercial integrated circuit fabrication. Thus, the radiation-hard process flow maintains about 85 percent of the process steps utilized for fabricating commercial circuits. The nature of the development program, combined

with standard design techniques, provides a radiation-hardened microcircuit capability that reflects the capabilities of the most advanced commercial devices, has long-term reliability, is hardened against nuclear effects, and achieves all this at low unit cost.

DECADE FACILITY



DNA Activities and Accomplishments

- Developing X-ray test facilities for hardness validation testing
 - DECADE: Hard X-rays for electronics
 - Jupiter: Soft X-rays for optics and sensors
- AGT/UGT correlation for high confidence
- Advance simulator technology

Technical Requirements

- Provide survivability tests if UGET is prohibited
- Emphasis on space-based system survivability
 - C³I - Detection and Tracking
 - Reconnaissance - Interceptors
- Formal Air Force (Space Div) Army (SDC), and SDIO requirements statements

Impact

- User-friendly X-ray test facilities
 - Electronics ensemble exposure (1 m²) at JCS levels
 - Optics/sensors at > JCS levels
- Will satisfy 80% of current UGET requirements
- Validate survivability via test results and AGT/UGT correlation
- Stepping stone to advanced above-ground testing

The DECADE radiation simulation facility is under construction at Arnold Engineering Development Center, Arnold Air Force Base, Tennessee, and is scheduled for completion in 1996. It will be an above ground test facility for validating electronic subsystems of national space assets against nuclear weapon X-ray effects. This is the predominant effect in space, and the deep penetrating "hard" X-rays are the ones that interfere with electronics. The DECADE facility will also be used to develop the technologies for developing future simulators such as one known as "Jupiter" that will handle the less penetrating soft X-rays effects which can damage optics and structures.

The original requirements for the DECADE facility were officially stated by the US Air Force's Space Division, the US Army Nuclear and Chemical Agency and the Space System Test Capability Panel Report (the Sevin Report). They support the need for testing of space systems' electronic ensembles to assure reliable operations in radiation environments. The requirement for the DECADE facility becomes even more critical as we loose the ability to perform underground nuclear effects testing.

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CONCLUSION

DNA IS THE PRIMARY CONTINUING REPOSITORY OF DOD NUCLEAR EXPERTISE FOR CERTAIN ESSENTIAL TECHNOLOGICAL, DEVELOPMENTAL, OPERATIONAL, AND OVERSIGHT FUNCTIONS

- Services not fully maintaining nuclear-related skills to meet future needs
 - Withdrawing from supporting nuclear competence, and/or maintaining system-specific skills-not readily transferrable
- DOE Labs technical strengths will not substitute for maintaining nuclear competence in DoD:
 - No operational or warfighting responsibilities
 - DNA S&T scope much broader in weapons effects, survivability, AGT simulators, electromagnetic propagation, etc.
- ARPA is not pursuing programs to maintain nuclear competence in weapons-related matters

The Task Force concluded first that DNA represents a unique focus and repository for certain key DoD nuclear expertise, both technical and operational. DNA's skills would be difficult if not impossible to replace. Their skills are valuable from day to day; in an emergency they could be priceless.

While DNA has always played a unique role, the services will, appropriately, need DNA even more as they dismantle large parts of their own nuclear structure. As the total population in the nuclear weapons areas is greatly reduced, further centralization is eminently reasonable. Such centralization, however, should be the result of deliberate decisions by DoD top management based on an in-depth review.

Although not discussed at length here, the Task force found that the DOE Labs' technical strengths complement, and in some areas overlap with those of DNA. The Task Force was impressed with the cooperative attitude expressed by DNA and DOE; however, the DOE lab's competence will not substitute for maintaining nuclear competence in DoD:

- 1) No operational or warfighting responsibilities
- 2) Limited capability to support operationally-oriented functions.

including training; fielding science and technology; stockpile management; target planning and analysis

- 3) DNA S&T base significantly different in weapons effects, survivability, AGT and simulators, electromagnetic propagation
- 4) DOE Labs design weapons; DNA must understand their effects, how to survive them, how to employ them. These are very different roles.

The Task Force found that APRA has essentially no nuclear weapon-related programs, nor are they interested in such programs.

EVOLVING NATIONAL MILITARY STRATEGY: A FRAMEWORK FOR FUTURE DNA ROLES

National Military Strategy, c. 1992

- Deterrence of war is still the primary U.S. goal
- Most U.S. military forces will be based in the U.S.
- Contingency (Joint and/or Combined) operations will be the norm
- Quick/decisive success with minimum friendly casualties will be imperative

The "New Threat"

- Strategic: Residual nuclear ICBM holdings in the FSU, China
- Contingency (Theater): Weapons of mass destruction (WMD), in Third World
 - Delivered by ballistic/cruise missiles, manned/unmanned aircraft, artillery
 - From fixed/mobile launchers, airfields, ships, submarines
 - Weapons stored in very hard shelters
 - GPS accuracies
 - Ranges: few to >1000 km
 - In critical areas large/modern conventional forces + WMD + TBM

The 1992 revision of the National Military Strategy sets forth the basic ideas which will drive national security matters for the foreseeable future. The ideas are:

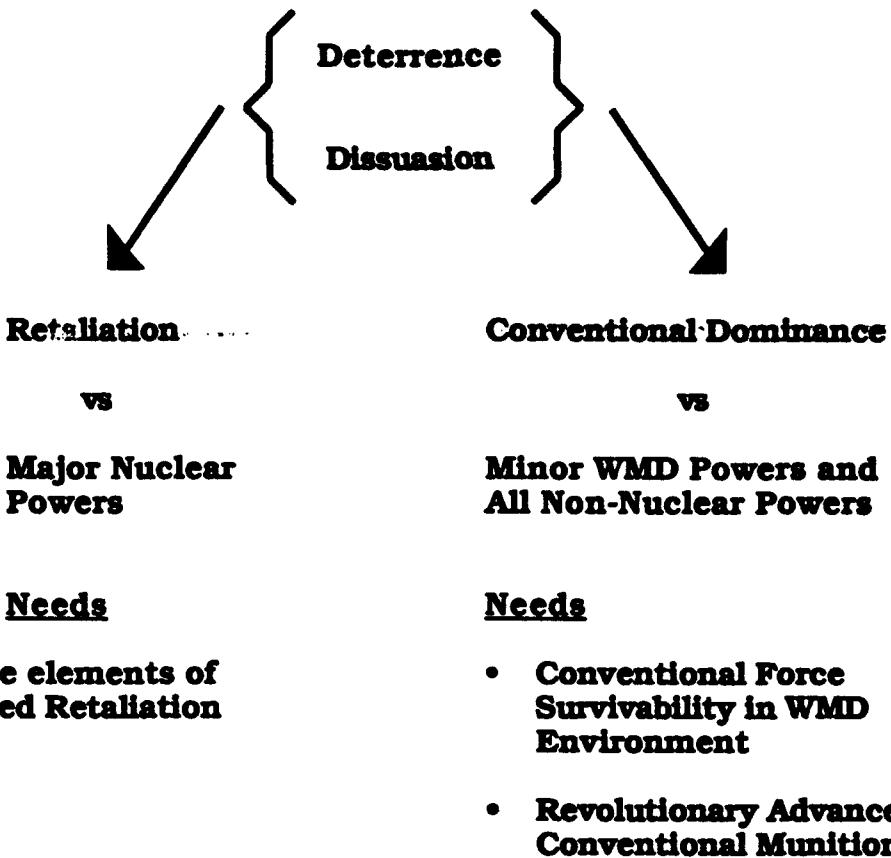
- 1) The basic U.S. National Security goal is still to deter war, even though the parameters of the deterrence equation may have changed dramatically since fractionation of the former Soviet Union.
- 2) The future will find most U.S. military forces based in the U.S.. Force projection, ever a problem even for NATO reinforcement, will remain a serious problem, absent forward based forces.
- 3) Contingency operations will likely be the dominant operational requirement. These operations will virtually always be joint or combined in nature.
- 4) Operationally, the demand will be for quick and decisive success with minimal friendly casualties. This requirement is driven by several factors; from the need to minimize long term logistical support demands, to the realities of sustaining over time public support in the U.S.

Risks and uncertainties abound in the post-Soviet world. Less dramatically apparent than the familiar NATO-Warsaw Pact confrontation, they are no less real. From the perspective of U.S. National Security they range from:

- The strategic threat residual in nuclear ICBM holdings of former Soviet Republics, and of the People's Republic of China, to
- Theater level (contingency) threats which include weapons of mass destruction (nuclear, chemical, biological), and growing delivery capabilities in the Third World. These include weapons delivered by:
 - Ballistic, semi-ballistic/cruise missiles; manned/unmanned aircraft, rocket artillery, stored in very hard underground structures, and launched from fixed or mobile launchers, airfields, shops, submarines.
 - Global positioning system accuracies, and delivery system ranges from a few to several thousand kilometers.

In many critical areas we can expect to encounter large modern conventional forces as well as weapons of mass destruction and theater level missile systems.

FUTURE NATIONAL MILITARY STRATEGY



Against those nations with nuclear-capable ICBMs, all the traditional elements of assured retaliation need to be sustained as first order U.S. military capabilities.

Against WMD and missile capable Third World threats, and all non-nuclear threats, the U.S. needs to field forces capable of rapid deployment, survival in a WMD environment, and defeat of the threat with a variety of revolutionary advanced capability conventional munitions.

NUCLEAR-RELATED CONVENTIONAL TECHNOLOGY SUPPORTING NEW NEEDS AND MISSIONS

Conventional Weapons Research

- Weapons Effect Phenomenology
- Hard Target Penetration Mechanics
- Advanced Explosives Effectiveness
- Target Lethality and Vulnerability
- Advanced Protective Construction
- Advanced Numerical/Physical Simulations
- KE Weapon Lethality

Advanced Pulsed Power Applications

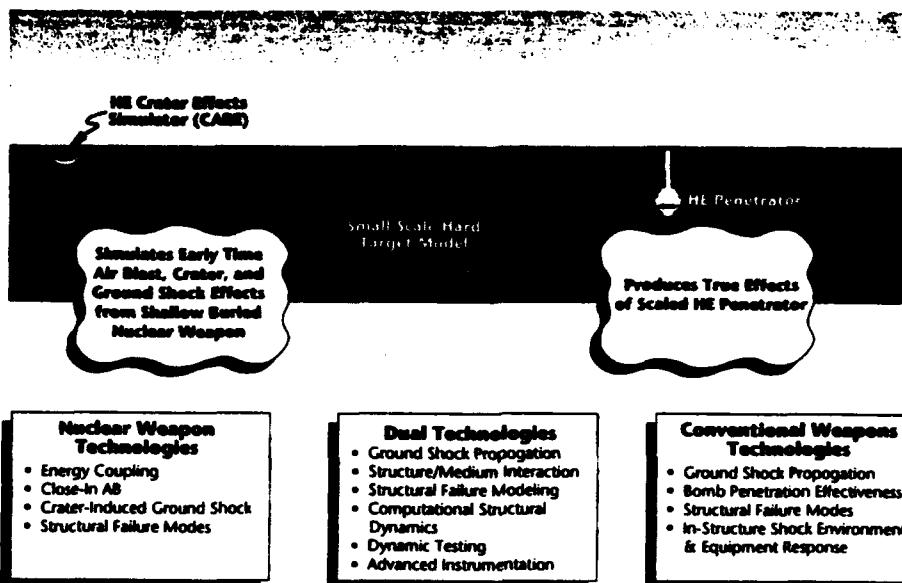
- Electric Gun Technologies
- Revolutionary Projectile Propulsion
- Advanced Energy Storage
- Advanced RF/DE Weapons
- Environmental Control

A number of areas in which DNA can make important contributions to the newest revolution in warfare are listed here. DNA is already performing leading work on a number of these topics, but it would be fruitful to expand DNA's role in a major way.

The next few charts give some specifics on current and projected DNA programs related to conventional weapons.

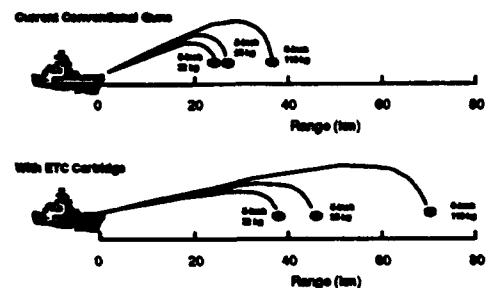
DUAL TECHNOLOGY EXAMPLE: PENETRATOR EFFECTIVENESS

DUAL TECHNOLOGY EXAMPLE: Penetrator Effectiveness Against Shallow Buried Hard Targets



DNA has pioneered the application of High Explosive (HE) simulations of nuclear weapon effects, in combination with small scale structural modeling, to study structural failure modes and damage mechanisms of shallow-buried hard targets. This technology has direct application to lethality studies of conventional earth penetrating weapons. The chart illustrates one manner in which this technology can be brought to bear, and how nuclear expertise can be "kept sharp" in the process.

ETC GUN TECHNOLOGY PROGRAM



Technical Requirement

- Significantly improve performance of existing large-bore guns via electrical energy

DNA Activities and Accomplishments

- First-ever code calculations of plasma-stimulated propellant burn in breech
- Designed "Piccolo" cartridge to optimize breech/barrel pressure-time history
- Achieved electrical control over gas generation rate to accommodate increased propellant charge
- Set World record in muzzle energy with 5" Naval gun

Impact

- Joint DNA-Navy program to demonstrate 2X (and possibly 4X) range extension of 5" Naval gun
- Underwrites Navy investment (>\$10B) in 5" guns
- Applicable to other key future missions, e.g., FOFA and TMD

Using its nuclear core competencies in pulse power and shock physics, DNA has developed processes for electrically controlling the release of large amounts of chemical energy and providing for enormous improvements in larger caliber guns. Tests have shown that the ranges of existing gun systems can be extended up to four times their current value, and theater missile defense projectiles can be launched to over 2.0 km/s velocities.

Responding to the Navy's interest in extending the range of existing guns, in September 1990, DNA began a research program to develop an energetic, controllable propulsion system. After only 14 months of analysis, hardware design, and sub-scale testing, DNA was firing ETC cartridges from existing 5 inch Navy guns. Two months later, DNA set a world record for the greatest muzzle energy achieved with an ETC gun. During the 24th month of the program, the goal of 80% performance enhancement using the ETC propulsion concept in an otherwise conventional gun was achieved. With Navy encouragement, DNA's now working toward 140% enhancement over a conventional gun for the fire support mission. The Navy is about to enter into a 4 year, \$90M, MOA with DNA to conduct a system advanced technology demonstration of this capability. The Navy has also expressed an interest in extending the application of this gun technology to the missions of fleet defense and TMD.

LOCATION OF UNDERGROUND FACILITIES AND BATTLE DAMAGE ASSESSMENT

Technical Requirement

- Develop conventional munitions effectiveness assessment (MEA) methodology for JTCG/ME
- Investigate sensor systems to accurately characterize battle damage to underground facilities
- Enhance effectiveness of HE weapons against large, hardened underground facilities

DNA Activities and Accomplishments

- Integrated test and analysis program to develop functional/physical kill criteria for hard targets
- Support development of enhanced lethality conventional warheads
- Perform feasibility demonstration of sensor systems to identify sensor system/data fusion architecture

Impact

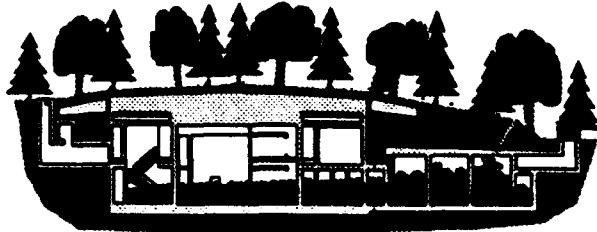
- DIA applied MEA methodology for optimized weapon-fuse combinations and aimpoints
- Automated targeting and MEA for JTCG/ME
- Lethality criteria for advanced conventional weapons development

DNA is testing advanced sensor systems to detect, characterize, and exploit underground facilities and accurately establish the extent of damage inflicted to these facilities during an attack. As in many program areas, DNA is working the offense and defense sides of the problem simultaneously. Sensors under investigation at this time include ground based (acoustic, seismic, and electromagnetic), multispectral imaging, and infrared. The program capitalizes on DNA's decades of experience in development of hardened underground facilities (such as the NATO command post at SHAPE), assistance to the intelligence community in analyzing foreign facilities, and development of unique instrumentation.

From the beginning of the hardened facility balanced survivability assessment program, efforts to reduce signatures and improve survivability of U.S. and Allied underground facilities and mobile systems led to an investigation of sensor technologies which might be employed to exploit these vulnerabilities. During operation Desert Storm, Iraq's ability to complicate coalition war plans using underground and bunkered facilities and mobile assets refocused attention on the requirement for advanced sensors systems. More than 50 nations are believed to rely on underground facilities for strategic and tactical purposes.

DNA is conducting tests at White Sands to determine the utility of advanced sensors to provide underground facility characterization and battle damage information. One of the sensors used in the damage signature program, multispectral imaging, has been employed to identify signatures and to provide the basis for an effective CC&D program for USCINCSpace's Mobile Command and Control Squadron.

ENHANCED PAYLOAD PROGRAM



Issue

Effectiveness of Conventional HE Weapons Against Large, Hardened Underground Facilities

- Localized Effects
- Primarily Mechanical Response

Products

- Fewer Weapons/Sorties Required to Neutralize Hardened Facilities
- Lower Cost and Less Risk
- Some Payload Weight Can Be Used For Rockets To Increase Penetration

Objective

To Achieve a Significant Improvement In the Mission Kill Effectiveness of Non-Nuclear Weapons Through:

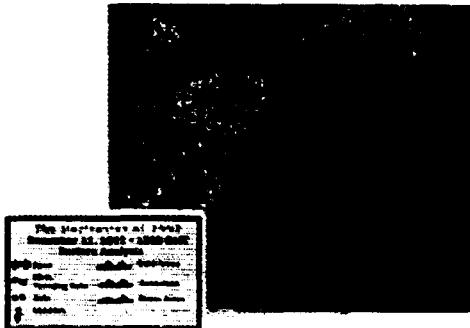
- Utilization of Advanced Technologies
- Innovative Application of Existing Technologies
- Exploitation of All Failure Mechanisms

Desert Storm experience, as well as recent DNA conventional weapons effects tests, has shown that conventional explosive-filled weapons can only damage small regions within large hardened underground facilities, even when the weapon detonates inside, since many of these facilities have substantial interior walls and/or floors which confine the blast and fragmentation. The problem is further compounded by the lack of reliable BDA capability for the class of target. Multiple attacks by either manned aircraft or cruise missiles would be very costly since hardened underground facilities are being increasingly used to protect a wide range of high value military assets (e.g., C³I, aircraft, mobile missiles and NBC production and storage facilities). Such targets cannot be ignored.

In response to this problem, DNA is initiating a research program to investigate the effectiveness of various unconventional (i.e., not traditional high explosive or nuclear) payloads for penetrating weapons. The focus is on identifying and evaluating new payload concepts which exhibit increased range to effect within hardened structures. Each technology will be developed into a penetrator payload concept and then demonstrated in laboratory and field testing. The ten performers in the program will investigate high explosive, fuel-air explosive, incendiary, explosive-driven,

**EMP, microwave, supershaped charge, magneto hydrodynamic,
superexplosive, and contaminant payload concepts.**

DISPERSAL HAZARDS PREDICTION MODEL



Technical Requirements

- Define dispersal hazards from nuclear, chemical, and biological release in real time anywhere in the world

DNA Activities and Accomplishments

- Develop source definition for NBC releases
- Develop a wind predictor that takes into account local topography and weather
- Develop a transport model that includes particle and aerosol evolution

Impacts

- Linked atmospheric dynamics and aerosol transport models
- Operational system to support CINCs

DNA is in the first year of a five year effort to develop a DoD Hazard Prediction and Assessment Capability (HPAC). The DNA Operations Center will oversee HPAC support for U.S. forces deployed worldwide. This is similar to the Operations Center's support provided during Desert Storm using the analytical capability then existing. Improved models are being developed to improve atmospheric transport and dispersion predictions. New databases are being developed to support assessments of conventional attacks against industrial targets with large inventories of hazardous materials.

The new atmospheric transport and dispersion model development is capitalizing upon over 15 years of DNA sponsored research and technology. This includes both numerical methods (e.g., flux corrected transport and other conservative algorithms and adaptive and unstructured grid methodologies) and physical modeling at cloud scale, mesoscale, and in the planetary boundary layer. The new OMEGA model represents a major application of DoD technology to atmospheric simulation. Its unstructured grid currently adapts to fixed features such as topography and will ultimately adapt dynamically to the evolving atmospheric conditions.

DNA is also developing databases of nuclear facilities (e.g., power plants) and chemical/biological facilities that are likely targets. Discussions

are being held with points of contact in responsible agencies and subject matter experts.

CONCLUSIONS

DNA's core competencies can make unique contributions to needed conventional force improvements

- **Survivability**
- **Munitions Lethality**
- **Revolutionary Conventional Munitions**

This leverage will contribute to maintaining critical nuclear capabilities at a lower overall cost and with greater stability, provided that the agency is appropriately staffed

Consideration of future defense requirements, DNA technical capabilities and fundamentals of R&D management leads us to these additional conclusions.

The previous charts have displayed how DNA technology can make major contributions to advances in conventional forces which will reduce further our reliance on nuclear weapons. We emphasize also that extensive R&D programs wisely chosen to employ DNA's technologies and skills will assist DNA to maintain the core nuclear weapon competencies in healthy condition and will not distract the Agency from its vital nuclear mission.

The Agency needs to be continually invigorated with a broad spectrum of new technologies and with competent, aggressive people. DNA must not be allowed to become a "nuclear backwater"; the way to avoid this is to maintain a critical mass of highly skilled people, many of whom work on important current applications of technologies that spin off from nuclear weapons work. This approach will be cost effective for the taxpayer and will preserve and enhance the nuclear knowledge.

SEPARATE ISSUES

UGETS

STOCKPILE MANAGEMENT

AFRRI

S&T MANAGEMENT

In addition to the issues related to nuclear and non-nuclear core competencies, the Task Force determined that the areas shown here deserved separate comments.

WHAT HAPPENS IF UNDERGROUND NUCLEAR EFFECTS TESTS (UGET) STOP?

- There is an essential difference between effects tests and weapon development, safety, and stockpile reliability tests.
- U.S. offensive weapon effects:
 - UGETs do not address many of the remaining uncertainties
 - Vigorous and sophisticated DNA effort through AGT and first principle computations has been necessary for years; it will continue
- U.S. Survivability:
 - Multi-megaton cold war scenarios considered unlikely; reduces need for certain UGET projects
 - New scenarios arise -- much smaller threats more likely; uncertainty of effects on many of today's critical warfighting systems; new systems may use untested and very vulnerable technology

The Task Force would be concerned, particularly about the survivability of new conventional systems and their associated information systems, if underground nuclear effects tests were not to resume. UGETs provide the most authentic simulation of nuclear radiation on representative size objects, short of exoatmospheric testing. While DNA has made, and continues to make, major advances in aboveground radiation effects simulators, they do not provide adequate test capabilities for system-level testing.

UGET (CONTINUED)

- **System level testing has almost always uncovered major design flaws**
 - One should assume this to be the case as well for new systems which tend to be smaller and more complex
- **Minimizing risks of unforeseen nuclear vulnerability and degraded system effectiveness will require more conservative design practices and/or survivability assessments**
 - Accept greater operational redundancy
 - Use "testable" hardware designs
 - De-rate system hardness
 - Accept greater weight and performance penalties (e.g., more shielding, greater design margins)
 - Accept lower confidence levels
- **Improve AGT capability**
- **Provide for rapid reconstitution**

A decision to cease UGET leads to risks of unforeseen nuclear vulnerability and degraded system effectiveness. This risk can be minimized if:

- 1) New scenarios and threats are addressed.
- 2) The technology bases necessary to understand nuclear weapons effects are preserved and nurtured.

Therefore: DNA should continue technology development for AGT and AGT/UGT correlation, with emphasis on new scenarios, but with the ability to reconstitute for UGT resumption.

STOCKPILE MANAGEMENT

Stockpile Management:

- Near real-time accounting for every nuclear weapon in DoD custody
- Joint Staff tests capability in exercises several times a year
- Not readily transferrable to conventional Service logistics enterprise

A "Core Competency" which

- Assures responsible stewardship of enduring stockpile and readiness for reconstitution
- Provides independent safety/security oversight
- Ensures connection with customer (CINCs/Services) and supplier (DOE)

Conclusions:

- Maintain Stockpile Management functions in DNA
 - Absorb related CINC/Service responsibilities as they are abandoned
- Formally allocate inactive reserve warheads to DNA
 - Make DNA responsible for inactive reserve stockpile (reconstitution and recertification)

While the Task Force was requested to look primarily at the Science and Technology mission, we were well briefed on DNA's operational mission of supporting the employment of nuclear weapons by the military forces. The major components of this mission are near-realtime stockpile management of weapons in DoD custody, as well as top-level inspections of all nuclear-capable units of U.S. forces, and exercises, training, and other activities to prepare for emergencies involving nuclear weapons.

While this operational mission accounts for a small fraction of DNA's budget, it is a labor intensive activity and occupies a large fraction of its people.

This is truly a core nuclear weapon competency. We believe there is substantial synergy between this operational mission and the Science and Technology work, and they should be kept together in the same agency. The operational arm of DNA could absorb related CINC/Service responsibilities, as needed. In addition, DNA should formally be assigned responsibility for the inactive reserve stockpile.

MILITARY RADIOBIOLOGY RESEARCH

- Under current plans, AFRRI will be transferred to USUHS on 1 Oct 93
 - Transition plan not complete
- Arguments pro and con
 - In our opinion, the pivotal issue is whether:
 - Radiobiology competence (a core competency) will be maintained better in the USUHS environment of broad research in the biological and health sciences, or whether
 - That broader environment in USUHS will, over time, submerge the radiobiology work
 - Intellectual market forces (military radiobiology "dirty business", radiobiology in general not glamorous, not career enhancing)
 - Funding will decline accordingly

CONCLUSIONS:

- Radiobiology Research needs continued emphasis
- Completion of transfer of AFRRI to USUHS should be contingent on DEPSECDEF review of a plan which includes:
 - Statement of USUHS commitment to maintain health of radiobiology
 - "Positive measures" for management arrangements to ensure maintaining emphasis (quality and quantity and funding)
- DNA should state its research requirements and commit funding to support that work
 - DNA budget adjustment to accomodate this funding
- Review USUHS performance periodically. Return to DNA if not satisfactory

About 15 percent of DNA's population is in the Armed Forces Radiobiological Research Institute, DNA's only in-house laboratory. AFRRI is a unique resource -- to the best of our knowledge, it is the only major laboratory in the world whose research focus is on effects of high levels of radiation (in contrast to safe levels) on human beings. It is located on the grounds of the Naval Hospital in Bethesda, next door to the Uniformed Services University of the Health Science (USUHS).

The current plan is that AFRRI will be transferred to the USUHS later this year. The Task Force is concerned about the transfer to another organization of a DNA core competency and urges that this transfer and subsequent performance be carefully and periodically monitored to assure retention of this competence in DoD. The DNA budget should be adjusted to accomodate AFRRI funding at USUHS.

SCIENCE AND TECHNOLOGY MANAGEMENT ISSUES

- DNA has important operational functions in support of nuclear services and CINCs, which will always require high-level military presence at DNA, but also has an important S&T mission
- DNA, over the years, has lost its visibility
 - Director used to be a 3-star
 - DNA no longer reports to JCS
 - Service nuclear role diminishing; some cold-war nuclear technology issues seen as already solved or currently low priority
 - Nonetheless, most Service and CINC nuclear organizations find DNA indispensable

CONCLUSIONS:

- DNA should report directly to USD(A), and have strong connections with both the Joint Staff and the ASD for Counter-Proliferation and Nuclear Security
- DNA Director should either be a 3-star with a long-term contract and a civilian deputy very strong in S&T; or a civilian very strong in S&T with a 2-star deputy
- The Director should be prepared to lead an enhanced DNA role in advanced conventional technology, while maintaining appropriate nuclear expertise, and the elements to whom he reports in OSD should ensure that both the nuclear and non-nuclear roles are appropriately institutionalized

The Task Force believes that DNA should report directly to the Under Secretary of Defense for Acquisition and should have close ties with the Joint Staff and the Policy side of the Defense Department.

Directors of DNA should be carefully chosen for their specific background and capability for this important position. The Director should be either a 3-star military officer assigned to the job for a longer period than the normal 2 or 3 years. If the SecDef does not wish to assign a 3-star officer, then an alternative is to assign a civilian who is a proven R&D executive. If the Director is a civilian, a military 2-star deputy should provide coupling of the operational mission into the forces.

CONCLUSION SUMMARY

- DNA is the only continuing repository of certain essential nuclear expertise for technical, developmental, operational, and oversight matters
- To protect nuclear competencies in an era of diminishing interest in nuclear matters, it is necessary to leverage related non-nuclear competencies within DNA
- UGET cessation leads to risks which can be minimized if new scenarios, e.g., lesser threat levels, are addressed, the technical base for hardening is preserved, and AGT simulation is pursued
- Stockpile Management Functions, to include stewardship of inactive reserve warheads, should be a DNA responsibility
- Radiobiology research needs continued emphasis
- Management of Science and Technology issues in nuclear-related matters must be maintained with sufficient visibility within DoD

Our conclusions are summarized here.

RECOMMENDATIONS

- DNA should be designated as the focal point for DoD core nuclear competencies (effects phenomenology/simulation, vulnerability and survivability, advanced technology application, employment support, and arms control/dismantlement)
- To ensure maintenance of nuclear-related core competencies and to leverage DNA expertise, the agency should have major involvement in countering WMD, including Theater Nuclear Survivability, and in Advanced Conventional Munitions
- DoD should support DNA technology development for future simulators: AGT/UGET correlation and new threat scenarios should be emphasized; the ability to reconstitute UGETs should be protected
- DNA should remain DoD's agent for Stockpile Management, inspections, and emergency actions and take formal responsibility for the inactive reserve stockpile
- DEPSECDEF should determine final disposition of AFRRRI based on ensured funding for and commitment to maintaining radiobiology research
- DNA should report directly to USD(A) (with coordination links to the Joint Staff and USDP) because of the importance of its increased roles. The Director should be a 3-star officer assigned for an extended period, or a civilian R&D executive with a 2-star deputy

For each conclusion, we have provided a recommendation.

FINAL THOUGHTS

- The issue is not just DNA - it's how the DoD, including OSD, Services, CINCs and DNA - will meet its continuing nuclear responsibilities in the future
- The issue is not just nuclear - it's how the DoD will make the best use of advanced technology to counter Nth country weapons of mass destruction
- We urge the Department and the Secretary to take a focused, comprehensive, and detailed look at these issues, going beyond our preliminary investigations:
 - Essential nuclear competencies of CINCs and Services and what should be consolidated into DNA
 - Effects of hostile nuclear weapons on theater CINC's forces
 - Need for DoD focal point for advanced munition technology, and countering WMD
 - Need for further consolidation of functions related to nuclear weapon planning and employment in support of Joint CINCs

In summary, our nation's nuclear responsibilities need continued and increased attention.

Our conclusions and recommendations focus this attention by allowing the Defense Nuclear Agency to continue their longstanding role in nuclear related matters; in addition we find that their competencies developed to support the nuclear arena have leveraging impact in non-nuclear weapons capabilities.

We further state that the DoD needs to take a detailed look at the entire structure of the nuclear and advanced conventional weapon area.

APPENDIX A

TERMS OF REFERENCE



DIRECTOR OF DEFENSE RESEARCH AND ENGINEERING

WASHINGTON, DC 20301-3010

21 JAN 1993

MEMORANDUM FOR CHAIRMAN, DEFENSE SCIENCE BOARD

SUBJECT: DSB Task Force on the Defense Nuclear Agency

You are requested to review the technology base program and technology application programs of the Defense Nuclear Agency (DNA) to determine the impact on national security of the possible cessation of underground nuclear weapons effects testing, and the potential decrease in the number of existing and new weapon systems where nuclear survivability is a high priority issue. The Task Force should determine what capabilities and expertise is required and how the DoD can best maintain these over the long term. Specific consideration should be given to continuing DNA in its historical role as the focal point within the DoD for nuclear weapons expertise, the impact of expanding DNA's role in the non-nuclear areas where its unique expertise can contribute to addressing specific requirements, changing DNA's RDT&E activities through closer collaboration with other DoD and U. S. Government laboratories, or by other means.

The Task Force will provide input on these scientific and technical issues to a DoD Review Team that I have asked to conduct a more wide-ranging view of the DNA's management authority, organizational structure, and staffing. The Task Force will coordinate its activities with the DoD team; a final briefing is required by March 15, 1993.

Dr. George Schneiter, as chairman of the DoD Review Team, will be the Task Force sponsor. Dr. John Cornwall has agreed to serve as the Chairman. Dr. Gene Sevin has been appointed as the Executive Secretary, and Colonel Ray Whitehouse will be the DSB Secretariat representative. It is not anticipated that your inquiry will need to go into any "particular matters" within the meaning of Section 208 of Title 18, United States Code.

MR
Victor H. Reis

APPENDIX B

MEMBERSHIP

DSB TASK FORCE MEMBERSHIP

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VAdm (Ret) John T. Parker
Gen. (Ret) Donn Starry
Dr. Richard L. Wagner, Jr.**

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